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(54) **HELMETS AND METHODS OF MAKING AND USING THE SAME**

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A62B 18/04	(2006.01)
A42B 3/00	(2006.01)

(52) **U.S. Cl.** **128/201.24**; 128/201.22; 128/201.23; 128/201.29; 128/204.18; 128/204.21; 2/410; 2/456; 2/457

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See application file for complete search history.

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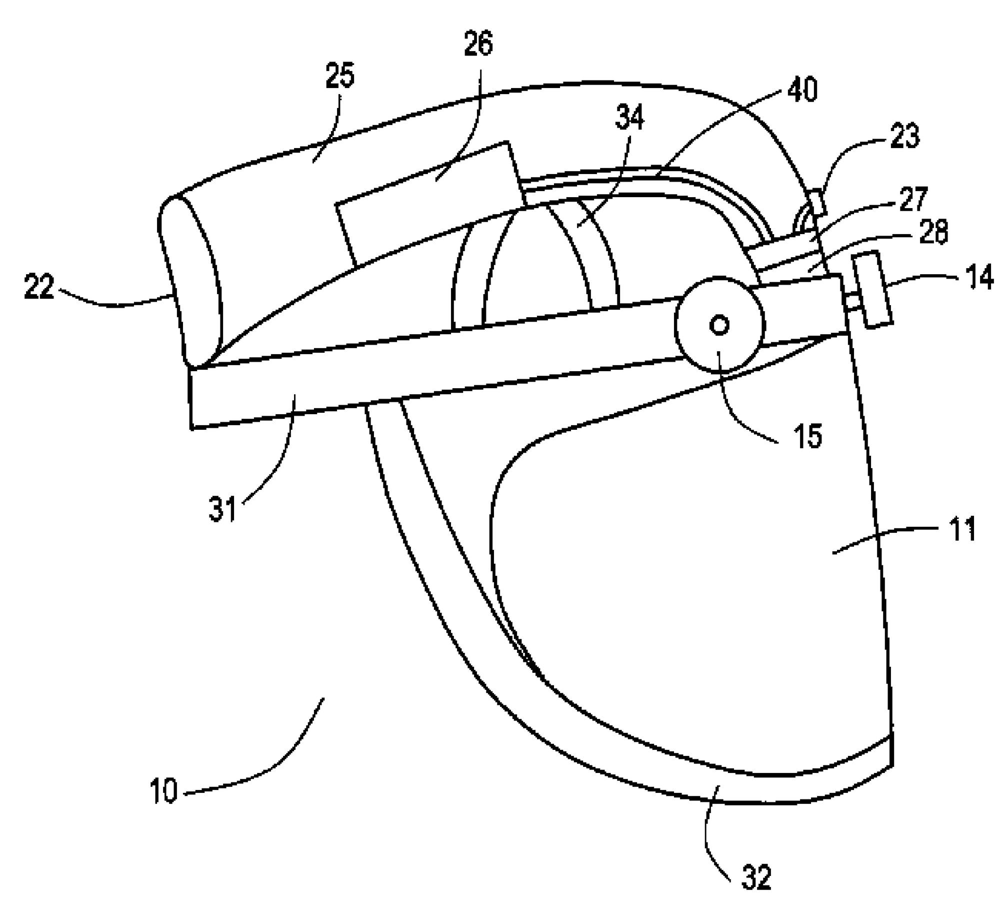
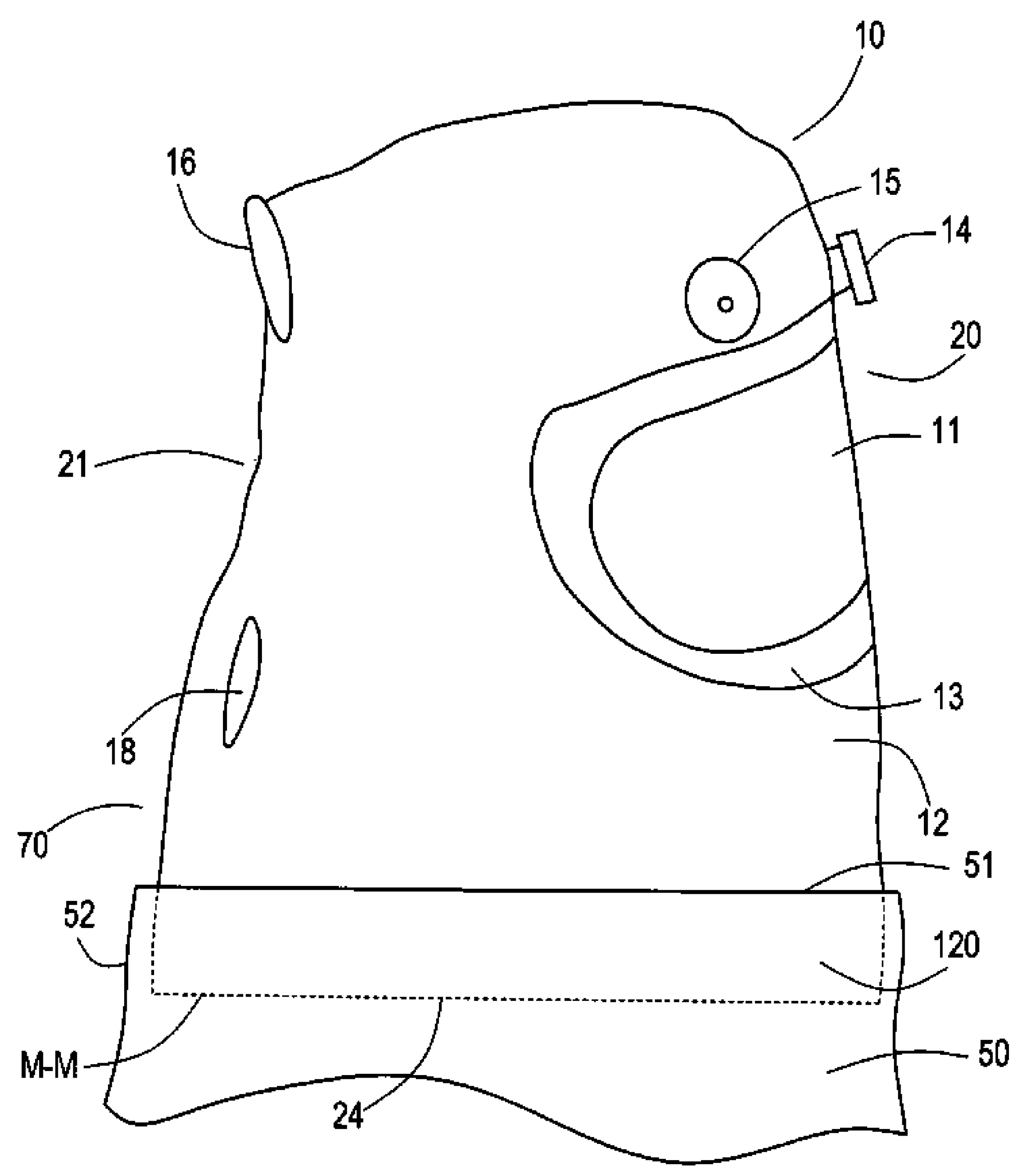
(57) **ABSTRACT**

The present invention is directed to a helmet suitable for use in an operating room setting, an emergency room setting, a hospital setting, or a lab. The helmet of the present invention provides one or more of the following features: (i) superior barrier protection to a surgeon (or other operating room personnel) during a surgical procedure, (ii) a desired degree of air flow through the helmet so as to minimize the potential for carbon dioxide buildup within the helmet, and (iii) an integrated battery pack positioned within the helmet.

18 Claims, 8 Drawing Sheets





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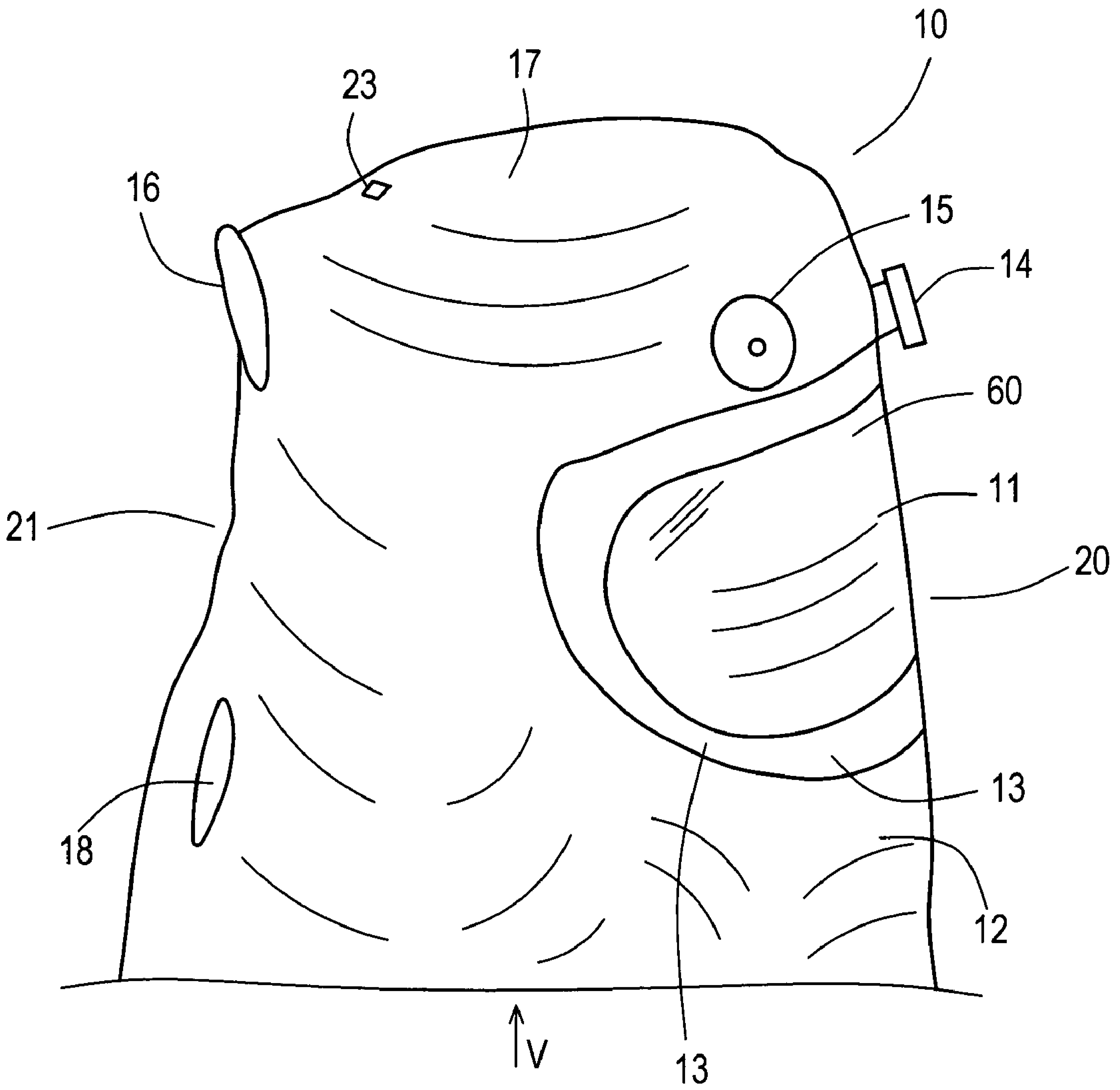

FIG. 1

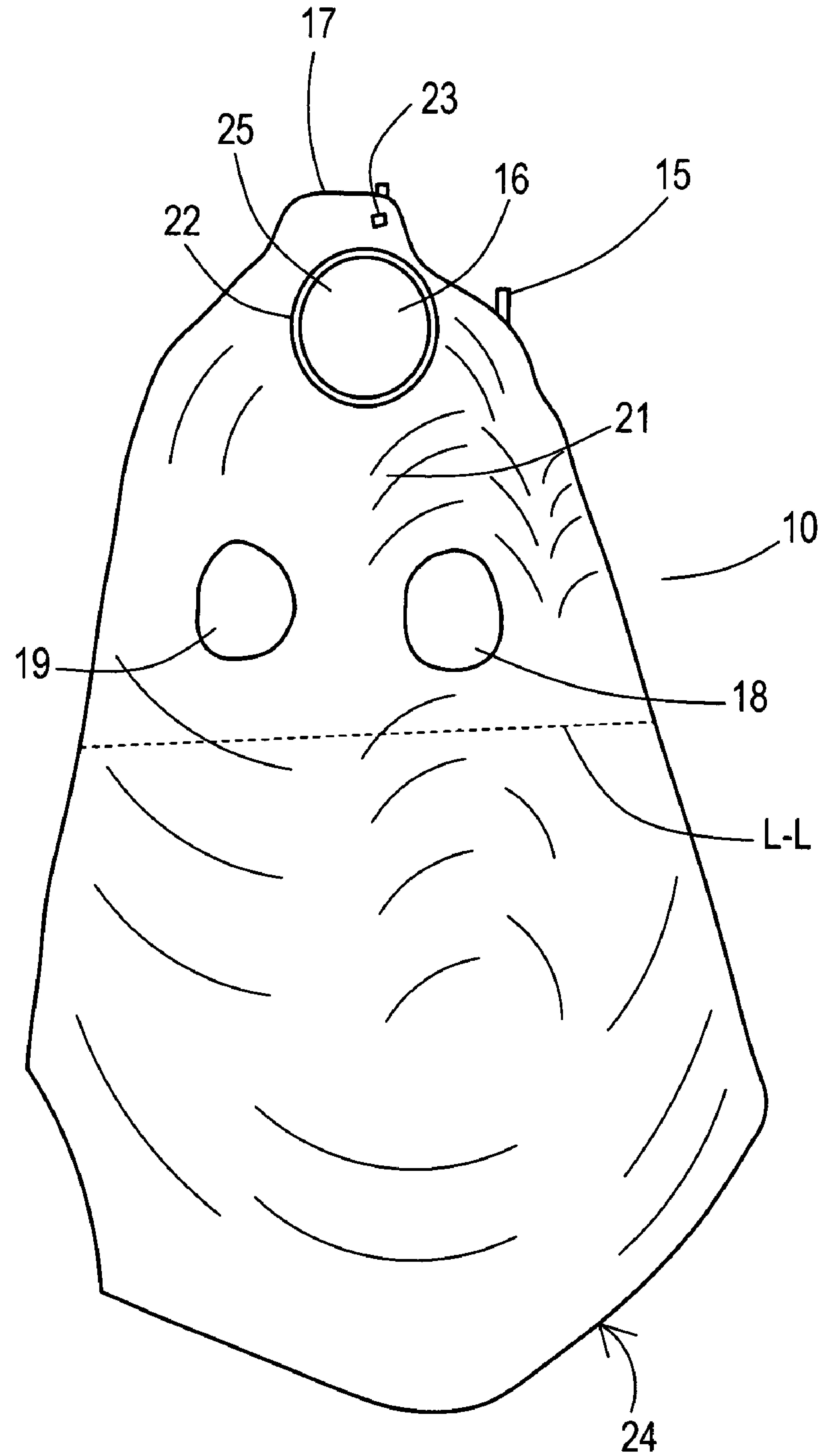

FIG. 2

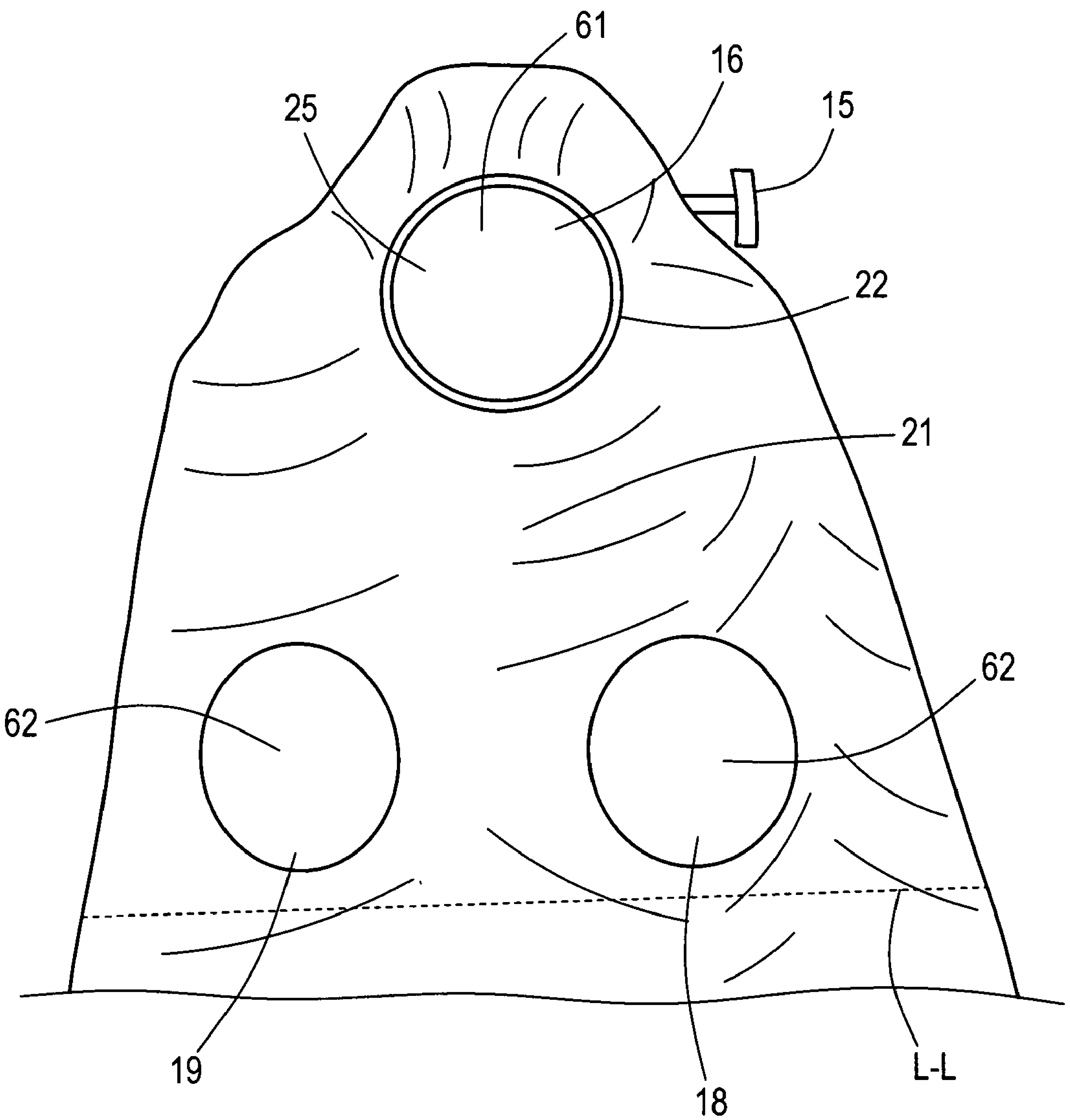

FIG. 3

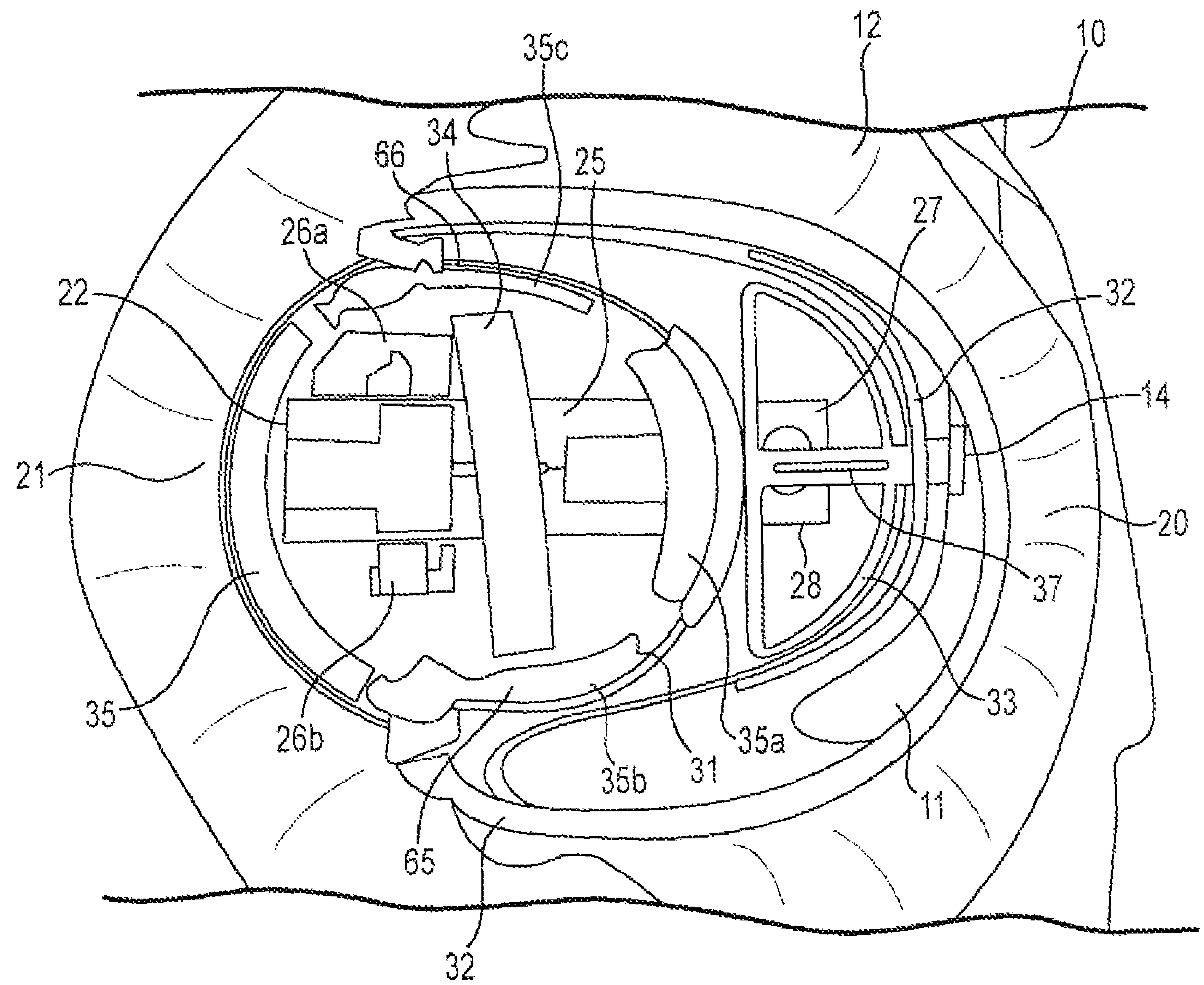
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FIG. 4

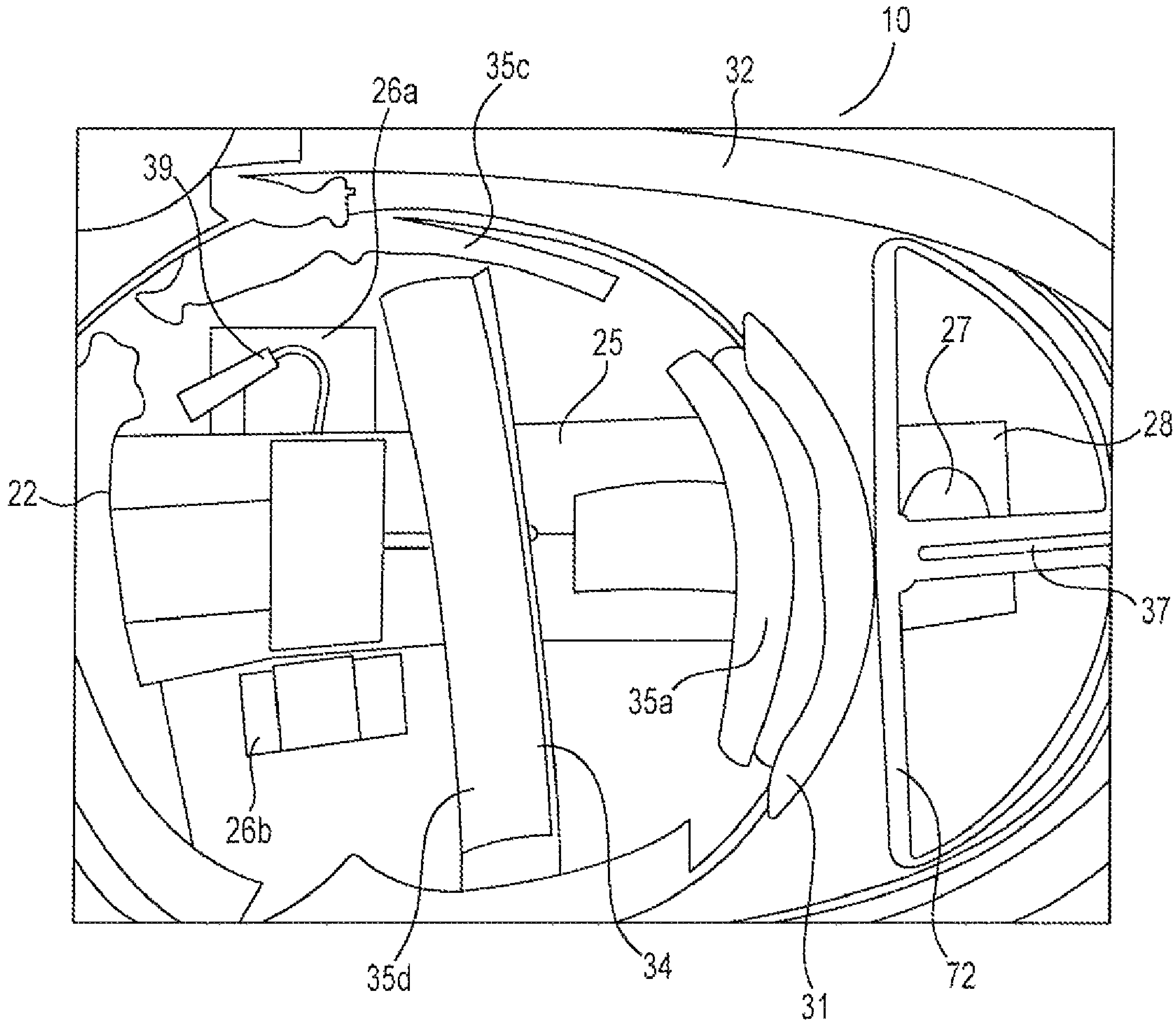

FIG. 5

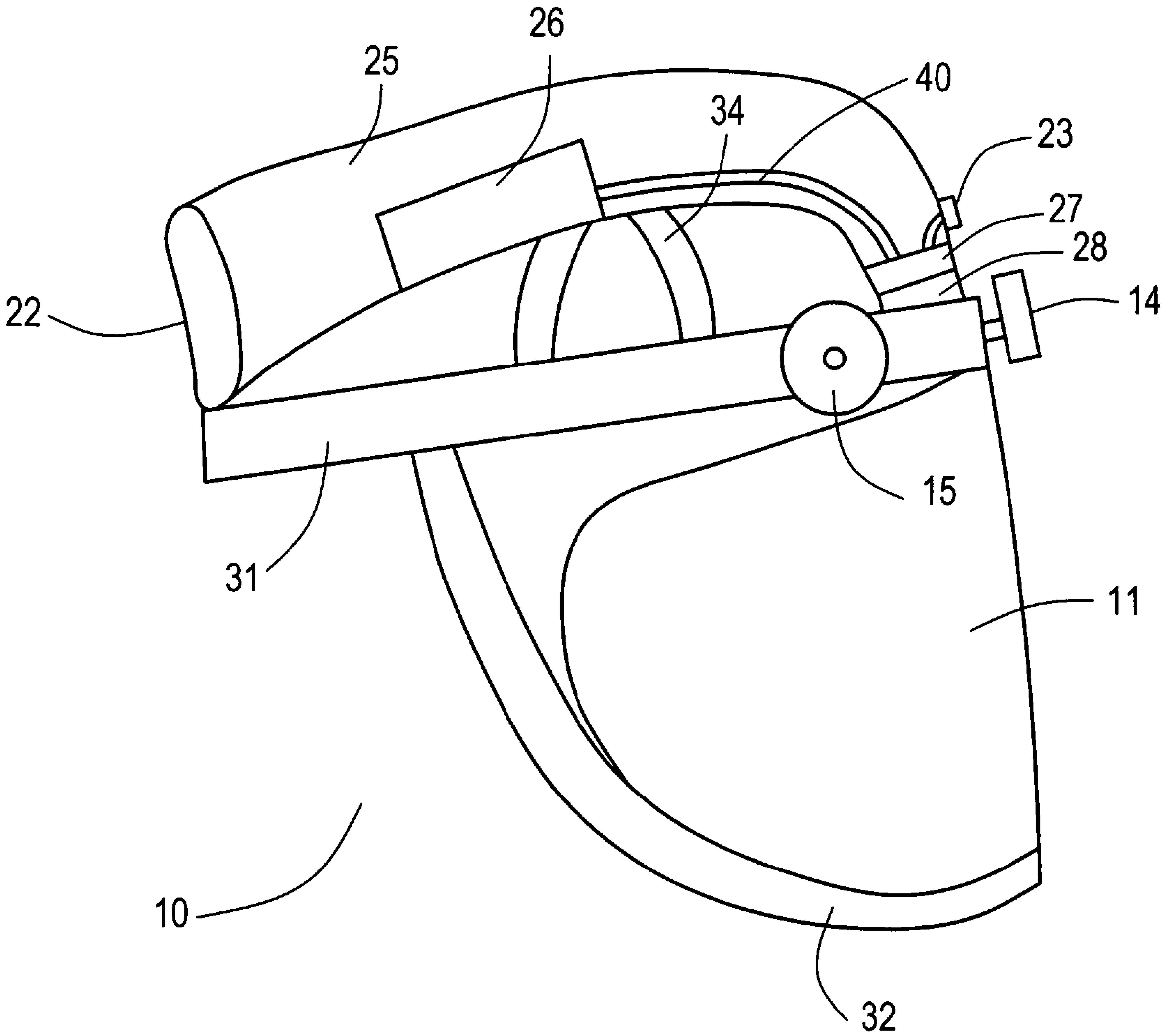

FIG. 6A

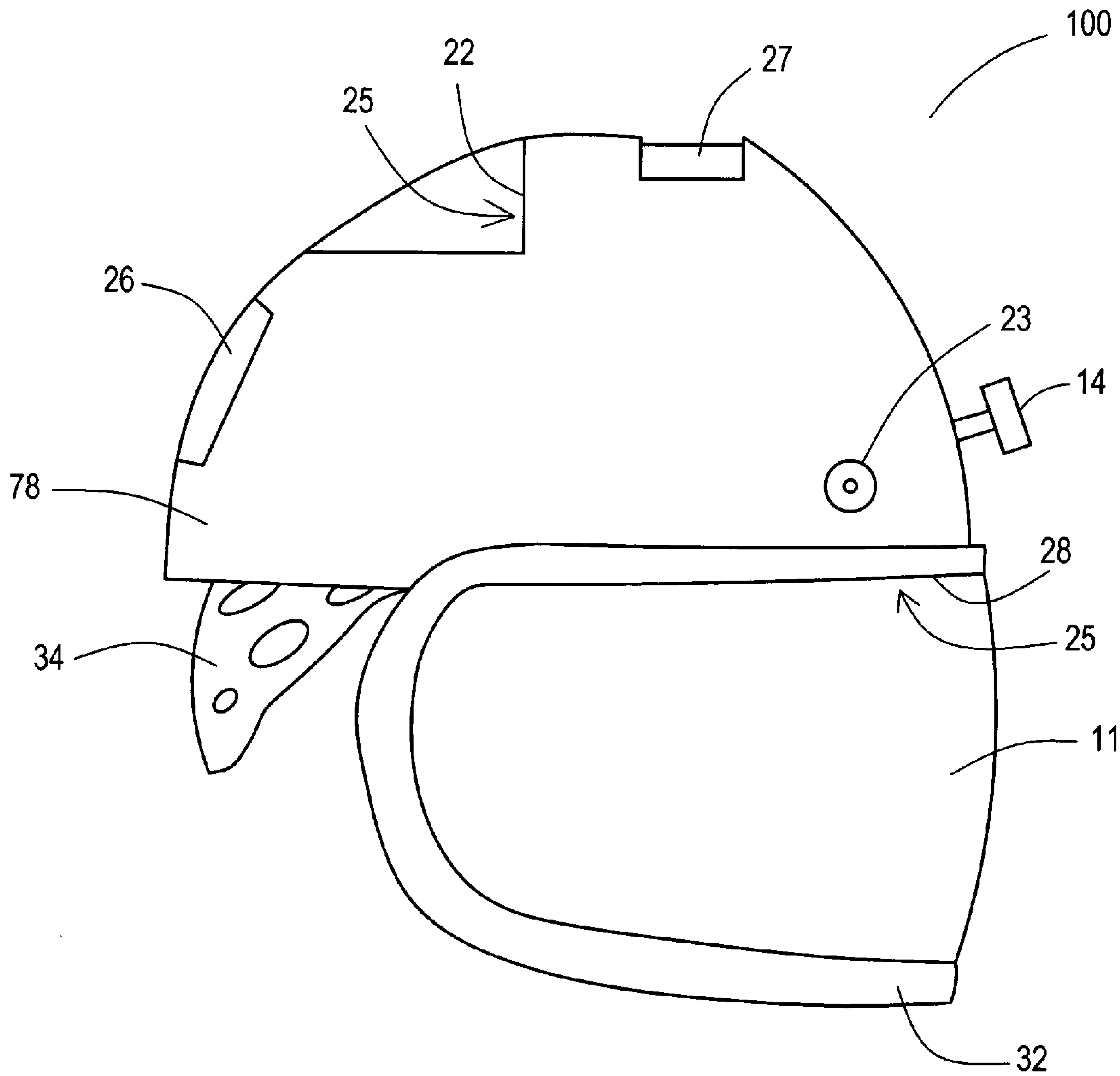

FIG. 6B

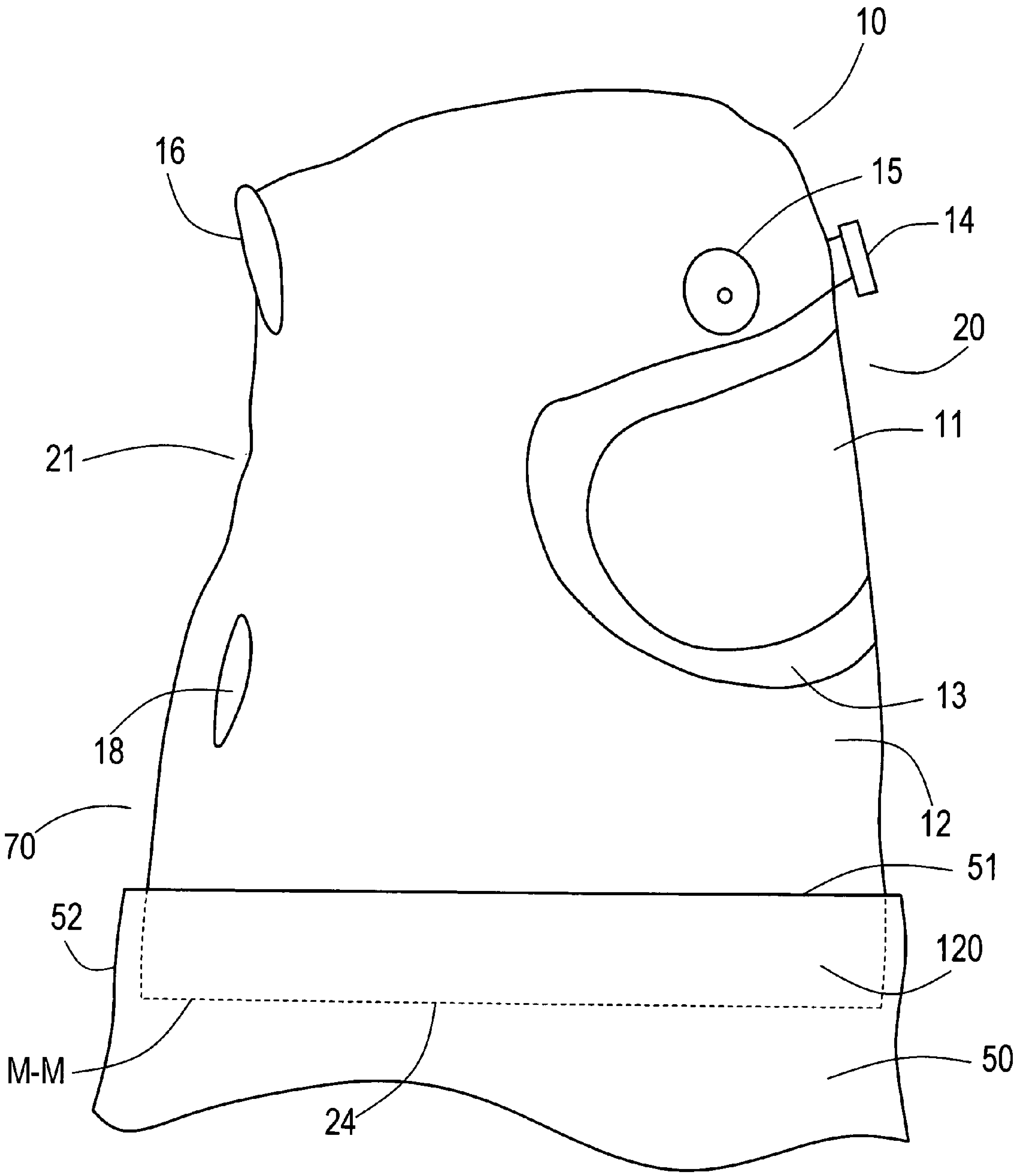

FIG. 7

HELMETS AND METHODS OF MAKING AND USING THE SAME

FIELD OF THE INVENTION

The present invention relates generally to helmets suitable for use in an operating room setting, methods of making helmets, and methods of using helmets, for example, in an operating room setting.

BACKGROUND OF THE INVENTION

A variety of disposable and reusable helmets are used in operating rooms. Helmets are used to protect and/or cover a surgeon or other operating room personnel such as during a surgical procedure. During surgical procedures, it is important for a helmet to provide a barrier between the surgeon (or other operating room personnel) and the patient so as to protect the surgeon (or other operating room personnel) from exposure to body fluids and any other contaminants. Efforts continue in the design of helmets to further enhance the properties and characteristics of helmets.

There is a need in the art for helmets that (i) are suitable for use in an operating room setting, (ii) provide superior barrier protection to a surgeon (or other operating room personnel) during a surgical procedure, (iii) provide a desired degree of air flow through the helmet so as to minimize the potential for carbon dioxide buildup within the helmet, (iv) are designed to be easily operational, (v) are designed without a separate battery pack and wires for connect the separate battery pack to the fan of the helmet, or (vi) any combination of items (i) to (v).

SUMMARY OF THE INVENTION

The present invention is directed to a helmet suitable for use in an operating room setting, an emergency room setting, a hospital setting, or a lab. The helmet of the present invention provides one or more of the following features: (i) superior barrier protection to a surgeon (or other operating room personnel) during a surgical procedure, (ii) a desired degree of air flow through the helmet so as to minimize the potential for carbon dioxide buildup within the helmet, and (iii) an integrated battery pack positioned within the helmet.

According to one exemplary embodiment of the present invention, the helmet comprises a frame operatively adapted to surround at least a portion of a person's head; a transparent face shield attached to the frame and positioned along a front side of the helmet; an air channel having at least one air inlet and at least one air outlet, the at least one air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield; a fan in fluid communication with the air channel, the fan being operatively adapted to move air through the air channel; a battery pack attached to the frame and positioned above a lower edge of the transparent face shield, the battery pack being operatively adapted to supply electrical power to the fan; and a hood surrounding the transparent face shield and extending over and downward from the frame.

According to a further exemplary embodiment of the present invention, the helmet comprises a frame operatively adapted to surround at least a portion of a person's head; a transparent face shield attached to the frame and positioned along a front side of the helmet; an air channel having at least one air inlet and at least one air outlet, the at least one air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield; a fan in fluid communication with the air channel, the fan being operatively adapted to move air through the air channel; a hood surrounding the transparent face shield and extending over and downward from the frame; at least one hood air inlet located within a periphery of the hood and aligned with the at least one air inlet of the air channel; and at least one hood air outlet located within a periphery of the hood, wherein the at least one hood air inlet and the at least one hood air outlet are operatively adapted to provide air flow through the helmet so as to decrease an amount of carbon dioxide buildup within the helmet.

The present invention is also directed to a surgical outfit comprising at least one helmet. In one exemplary embodiment, the surgical outfit comprises a helmet, and a surgical gown sized so as to extend from a neck region of a user to a waist region or below, wherein the hood of the helmet is sized so as to extend below the neck region of the user, and when a lower portion of the hood is tucked within an upper portion of the surgical gown, the at least one air outlet of the hood, when present, is positioned above the surgical gown. In this embodiment, the helmet may comprise (i) a hood comprising at least one air outlet, (ii) a battery pack attached to the frame of the helmet and positioned above a lower edge of a transparent face shield of the helmet, or (iii) both (i) and (ii).

The present invention is further directed to methods of making a helmet such as a helmet suitable for use in an operating room setting. In one exemplary embodiment of the present invention, the method of making a helmet comprises providing a frame of a helmet, the frame being operatively adapted to surround at least a portion of a person's head; attaching a transparent face shield to the frame so as to be positioned along a front side of the helmet; providing an air channel having at least one air inlet and at least one air outlet, the at least one air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield, the air channel being attached to or integrally formed into the frame; providing a fan in fluid communication with the air channel, the fan being operatively adapted to move air through the air channel; incorporating a battery pack into the helmet so as to be positioned above a lower edge of the transparent face shield, the battery pack being operatively adapted to supply electrical power to the fan; and providing a hood that surrounds the transparent face shield and extends over and downward from the frame.

In a further exemplary embodiment of the present invention, the method of making a helmet comprises providing a frame of a helmet, the frame being operatively adapted to surround at least a portion of a person's head; attaching a transparent face shield to the frame so as to be positioned along a front side of the helmet; providing an air channel having at least one air inlet and at least one air outlet, the at least one air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield, the air channel being attached to or integrally formed into the frame; providing a fan in fluid communication with the air channel, the fan being operatively adapted to move air through the air channel; and attaching a hood to the frame so as to surround the transparent face shield and extend over and downward from the frame, the hood comprising (i) at least one hood air inlet located within a periphery of the hood and aligned with the at least one air inlet of the air channel, and (ii) at least one hood air outlet located within a periphery of the hood, wherein the at least one hood air inlet and the at least one hood air outlet are operatively adapted to provide air flow through the helmet so as to decrease an amount of carbon dioxide buildup within the helmet.

The present invention is even further directed to methods of using a helmet in an operating room setting. In one exemplary embodiment of the present invention, the method comprises providing a helmet such as one of the above-described helmets; and cutting on the fan to provide an air flow path from into the at least one hood air inlet, to the at least one air inlet, through the air channel, out of the at least one air outlet into a region of the helmet bound by the transparent face shield, and out of the helmet through the at least one hood air outlet.

The present invention is even further directed to methods of reducing an amount of carbon dioxide within a surgical outfit during use. In one exemplary embodiment, the method comprises providing a surgical outfit of the present invention (such as the above-described surgical outfit or any surgical outfit described below), and cutting on the fan to provide an air flow path through an air inlet in a surgical gown, at least one hood air inlet in a helmet, to at least one air inlet, through an air channel, out of at least one air outlet into a region of the helmet bound by a transparent face shield, out of the helmet through at least one hood air outlet, and out of the surgical gown through at least one air outlet in the surgical gown. The surgical outfit of the present invention is capable of reducing an amount of carbon dioxide within the surgical outfit during use to below about 2500 ppm, and even below about 1800 ppm.

These and other features and advantages of the present invention will become apparent after a review of the following detailed description of the disclosed embodiments and the appended claims.

BRIEF DESCRIPTION OF THE FIGURES

The present invention is further described with reference to the appended figures, wherein:

FIG. **1** depicts a side view of an exemplary helmet of the present invention;

FIG. **2** depicts a rear view of the exemplary helmet of FIG. **1**;

FIG. **3** depicts a close-up rear view of the exemplary helmet of FIG. **1**;

FIG. **4** depicts a view of the exemplary helmet of FIG. **1** when viewed from below the helmet;

FIG. **5** depicts a close-up view of the frame, air channel, battery pack, and fan of the exemplary helmet of FIG. **1** when viewed from below the helmet;

FIG. **6**A depicts a side view of the exemplary helmet of FIG. **1** when the hood is removed;

FIG. **6**B depicts a side view of another exemplary helmet shown without a hood component; and

FIG. **7** depicts an exemplary surgical outfit comprising the exemplary helmet of FIG. **1** in combination with a surgical gown.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed to helmets suitable for use in any environment in which a helmet is typically used including, but not limited to, an operating room setting, an emergency room setting, a hospital setting, a lab, a clean room, etc. The present invention is further directed to methods of making helmets and using helmets in an operating room setting or any of the above-mentioned environments. The helmets of the present invention are particularly useful in providing a barrier between a surgeon and a surgical site of a patient.

In one exemplary embodiment of the present invention, the helmet comprises a frame operatively adapted to surround at least a portion of a person's head; a transparent face shield attached to the frame and positioned along a front side of the helmet; an air channel having at least one air inlet and at least one air outlet, the at least one air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield; a fan in fluid communication with the air channel, the fan being operatively adapted to move air through the air channel; a hood surrounding the transparent face shield and extending over and downward from the frame; at least one hood air inlet located within a periphery of the hood and aligned with the at least one air inlet of the air channel; and at least one hood air outlet located within a periphery of the hood, wherein the at least one hood air inlet and the at least one hood air outlet are operatively adapted to provide air flow through the helmet so as to decrease an amount of carbon dioxide buildup within the helmet.

In other exemplary embodiments of the present invention, the helmet comprises a frame operatively adapted to surround at least a portion of a person's head; a transparent face shield attached to the frame and positioned along a front side of the helmet; an air channel having at least one air inlet and at least one air outlet, the at least one air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield; a fan in fluid communication with the air channel, the fan being operatively adapted to move air through the air channel; a battery pack attached to the frame and positioned above a lower edge of the transparent face shield, the battery pack being operatively adapted to supply electrical power to the fan; and a hood surrounding the transparent face shield and extending over and downward from the frame.

In yet other exemplary embodiments of the present invention, the helmet comprises a frame operatively adapted to surround at least a portion of a person's head; a transparent face shield attached to the frame and positioned along a front side of the helmet; an air channel having at least one air inlet and at least one air outlet, the at least one air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield; a fan in fluid communication with the air channel, the fan being operatively adapted to move air through the air channel; a battery pack attached to the frame and positioned above a lower edge of the transparent face shield, the battery pack being operatively adapted to supply electrical power to the fan; a hood surrounding the transparent face shield and extending over and downward from the frame; at least one hood air inlet located within a periphery of the hood and aligned with the at least one air inlet of the air channel; and at least one hood air outlet located within a periphery of the hood, wherein the at least one hood air inlet and the at least one hood air outlet are operatively adapted to provide air flow through the helmet so as to decrease an amount of carbon dioxide buildup within the helmet. An exemplary helmet **10** having the above features is shown in FIG. **1**.

As shown in FIG. **1**, exemplary helmet **10** comprises a transparent face shield **11** along a front side **20** of helmet **10**, and a hood **12** surrounding an outer periphery **13** of transparent face shield **11** and extending over and downward from a frame of helmet **10** (e.g., frame **31** shown in FIG. **6** below). Exemplary helmet **10** further comprises knobs **14** and **15** that can be used to adjust the dimensions of the frame so as to better fit onto the head of a user. Knob **14** can be used to adjust a length (i.e., a first dimension extending from front side **20** to rear side **21**) and a width of the frame (i.e., a dimension extending perpendicular to the first dimension, e.g., across transparent face shield **11**). Knob **15** can be used to adjust a damper positioned within a vicinity of an air outlet into the helmet. (See, for example, damper **72** in FIG. **5**, which is shown in an "up" position, but can be rotated into a "down" position away from wall **73** of second frame component **33** to block air flow coming out of air outlet **28**.)

Exemplary helmet **10** further comprises an air channel air channel extending along upper region **17** of helmet **10** and having at least one air inlet (e.g., air inlet **22** shown in FIG. **2**) and at least one air outlet (e.g., air outlet **28** shown in FIG. **4**), wherein the at least one air outlet is positioned so as to provide air to a space **60** bound by an inner surface of transparent face shield **11**. A fan (e.g., fan **27** shown in FIG. **4** below) is in fluid communication with the air channel, and is operatively adapted to move air through the air channel.

As shown in FIG. **1**, in some desired embodiments of the present invention, exemplary hood **12** of exemplary helmet **10** comprises (i) at least one hood air inlet **16** located within a periphery of hood **12** and aligned with the at least one air inlet (e.g., air inlet **22** shown in FIG. **2**) of the air channel, and (ii) at least one hood air outlet **18** located within a periphery of hood **12**. Hood air inlet **16** and hood air outlet **18** are operatively adapted to provide air flow through helmet **10** so as to decrease an amount of carbon dioxide buildup within helmet **10**. Desirably, hood air inlet(s) **16** and hood air outlet(s) **18** are positioned along a rear side **21** of helmet **10** opposite transparent face shield **11** (see, for example, FIG. **2**); however, it should be understood that hood air inlet(s) **16** and hood air outlet(s) **18** may be positioned along any location of helmet **10** as long as hood air inlet(s) **16** and hood air outlet(s) **18** provide air flow through helmet **10** so as to decrease an amount of carbon dioxide buildup within helmet **10**.

FIG. **2** provides a rear view of exemplary helmet **10**. As shown in FIG. **2**, exemplary hood **12** of exemplary helmet **10** comprises (i) a single hood air inlet **16** located within a periphery of hood **12**, and (ii) two substantially similar hood air outlets **18** and **19** located within a periphery of hood **12**, below hood air inlet **16**, and positioned side-by-side along a neck region of hood **12**. As shown in FIG. **2**, hood air inlet **16** is located within a periphery of the hood and aligned with air inlet **22** of air channel **25**. Hood air outlets **18** and **19** are located within a periphery of the hood, and positioned below hood air inlet **16**. In this exemplary embodiment, air enters helmet **10** at a position above a user's head, and exits helmet **10** along a neck region of the user as designated by dashed line L-L. Exemplary hood **12** extends below dashed line L-L to lower edge **24** of hood **12**.

In the exemplary embodiment of FIG. **2**, exemplary helmet **10** comprises a power switch **23** positioned along upper region **17** of helmet **10**. Power switch **23** is operatively adapted to switch from an "off" position to an "on" position so as to supply power to the fan (e.g., fan **27** shown in FIG. **4** below) and turn off power to the fan. In other exemplary embodiments, power switch **23** is provided in other locations such as a position along an upper periphery of transparent face shield **11** (see, for example, power switch **23** shown in FIG. **6**).

FIG. **3** provides a rear close-up view of exemplary helmet **10**. As shown in FIG. **3**, a first air filtration material **61** forms hood air inlet **16** of exemplary hood **12**, and a second air filtration material **62** forms hood air outlets **18** and **19** of exemplary hood **12**. First air filtration material **61** and second air filtration material **62** may comprise a variety of filtration materials. Typically, each of first and second air filtration materials **61** and **62** comprises a nonwoven fabric, such as a spunbonded fabric, a spunlaced fabric, a needle-punched fabric, a melt-blown fabric, or any combination thereof. In one desired embodiment, each of first and second air filtration materials **61** and **62** comprises a spunbonded fabric, such as a nylon spunbonded fabric commercially available under the trade designation CEREX® from Cerex Advanced Fabrics, Inc. (Pensacola, Fla.).

Typically, each of first and second air filtration materials **61** and **62** comprises a nonwoven fabric having a fabric basis weight of less than 100 grams per square meter (gsm) (more typically, from about 9 gsm to about 95 gsm, even more typically, from about 15 gsm to about 50 gsm) and a fabric thickness of less than about 150 microns (μm), typically, from about 75 μm to about 100 μm.

The remaining portions of hood **12** (i.e., all of hood **12** other than hood air inlet **16** and hood air outlets **18** and **19**) typically comprise a fluid/blood barrier material. The fluid/blood barrier material typically comprises a nonwoven fabric or nonwoven fabric/film laminate and is used to form the remaining portions of hood **12**. In one desired embodiment, the fluid/blood barrier material comprises any breathable viral barrier (BVB) fabric commercially available from Ahlstrom Corporation (Alpharetta, Ga.), such as a BVB trilaminate polypropylene material.

FIG. **4** provides a view of exemplary helmet **10** of FIG. **1** when viewed from below helmet **10** (e.g., when viewed from position V shown in FIG. **1**). As shown in FIG. **4**, exemplary helmet **10** comprises frame **30**, which is operatively adapted to surround at least a portion of a person's head (not shown). Frame **30** typically comprises one or more frame components. In exemplary helmet **10**, frame **30** comprises the following frame components: adjustable frame component **31**, which extends around at least a portion of a person's head and can be adjusted in length and width dimensions using knob **14** as described above; frame component **32**, which at least partially surrounds transparent face shield **11** and attaches transparent face shield **11** to other helmet components; frame component **33**, which extends along a front side **20** of exemplary helmet **10** and connects adjustable frame component **31** to frame component **32**; knob extension member **37** extending along a portion of frame component **33** and being rotatably connected to knob **14**; and frame component **34**, which extends from a first location **65** along adjustable frame component **31** to a second location **66** along adjustable frame component **31** and is operatively adapted to conform to an outer contour of a person's head.

As shown in FIG. **4**, exemplary helmet **10** may further comprise pads **35*a***, **35*b***, and **35*c*** positioned along one or more of the above-described frame components. As shown in FIG. **4**, exemplary helmet **10** comprises multiple pads **35*a***, **35*b***, and **35*c*** positioned along adjustable frame component **31** and a single pad **35*d*** (shown in FIG. **5**) positioned along frame component **34**.

FIG. **4** provides a view of a battery pack **26** that is present in some helmets of the present invention. As shown in FIG. **4**, exemplary battery pack **26** comprised of two portions designated as **26*a*** and **26*b*** in FIGS. **4** and **5** is positioned along opposite sides of air channel **25**. Electrical wiring (not shown) connects battery pack **26** to fan **27** and power switch **23** (shown in FIGS. **2** and **6**). Although shown on opposite sides of air channel **25**, it should be understood that battery pack **26** may be located along any portion of frame **30**. Desirably, as shown in FIGS. **4-6**, battery pack **26** is located above a lower edge of the transparent face shield, more desirably, above an upper portion of the transparent face shield and along one or both sides of air channel **25**.

FIG. **5** provides a close-up view of various helmet components within exemplary helmet **10**. As shown in FIG. **5**, exemplary helmet **10** comprises air channel **25** extending between air inlet **22** and air outlet **28**. Battery pack **26** comprised of two portions designated as **26*a*** and **26*b*** in FIGS. **4** and **5** is positioned along opposite sides of air channel **25**. Electrical wiring **39** connects battery pack **26***a* and **26***b* to fan **27** and power switch **23** (shown in FIGS. **2** and **6**). As shown in FIG. **5**, fan **27** is positioned within air channel **25** in the vicinity of air outlet **28**. However, it should be understood that fan **27** may be positioned at any location within air channel **25** or at air inlet **22**. Damper **72** is positioned adjacent wall **73** of second frame component **33** in an "up" position, but can be rotated into a "down" position away from wall **73** and over air outlet **28** to block and/or redirect air flow through helmet **10**. The degree of air blockage and air flow direction can be controlled by rotating knob **15** as discussed above.

FIG. **6**A provides a side view of exemplary helmet **10** of FIG. **1** when hood **12** is removed. As shown in FIG. **6**A, exemplary helmet **10** comprises adjustable frame component **31** dimensioned so as to extend around at least a portion of a person's head; knobs **14** and **15**, which are operatively adapted to adjust dimensions of adjustable frame component **31** and air flow through the helmet respectively; first frame component **32** partially surrounding transparent face shield **11**; third frame component **34**, which is operatively adapted to conform to an outer contour of a person's head; battery pack **26**; fan **27**; air channel **25**; air inlet **22**; air outlet **28**; electrical wiring **40** connecting battery pack **26** to fan **27**; and power switch **23**.

FIG. **6**B provides a side view of another exemplary helmet **10** without a hood component. As shown in FIG. **6**B, exemplary helmet **100** comprises molded helmet component **78**; knob **14**, which is operatively adapted to adjust dimensions of a frame component (not shown but similar to adjustable frame component **31** shown in FIG. **6**A) extending around at least a portion of a person's head; first frame component **32** partially surrounding transparent face shield **11**; third frame component **34**, which is operatively adapted to conform to an outer contour of a person's head; battery pack **26**; fan **27**; air channel **25**; air inlet **22**; air outlet **28**; electrical wiring connecting battery pack **26** to fan **27** (not shown, but typically within or along an inner surface of helmet component **78**); and power switch/knob **23**, which is operatively adapted to provide electricity to the fan and adjust the fan speed (i.e., air flow through the helmet).

As shown in FIG. **6**B, fan **27** can be positioned near air inlet **22** of air channel **25**. Further, battery pack **26** can be positioned along a rear outer surface of helmet component **78**. Although power switch/knob **23** is shown as a single switch/knob on exemplary helmet **100**, it should be understood that a separate on/off switch and a separate air speed control knob could be present on exemplary helmet **100**. As discussed above, multiple air inlets **22** and/or air outlets **28** could be utilized on exemplary helmet **100** to provide air flow through exemplary helmet **100**. Further, one or more air inlets **22** and/or air outlets **28** can be positioned on exemplary helmet **100** in any desired locations so as to provide air flow through exemplary helmet **100**.

In one exemplary embodiment, any of the above-described helmets are sterilized prior to use. For example, in an operating room setting, a sterile field must be maintained around a surgical procedure site. Consequently, a surgical helmet used during such a surgical procedure must be sterilized prior to use.

Typically, the helmets of the present invention are disposable. However, in some cases, the helmets of the present invention may be reusable. When reused, the helmet may need to be subjected to a cleaning procedure and/or sterilization procedure prior to reuse.

The present invention is also: directed to a surgical outfit comprising at least one helmet. An exemplary surgical outfit is shown in FIG. **7**. As shown in FIG. **7**, exemplary surgical outfit **70** comprises exemplary helmet **10** (or exemplary helmet **100**) in combination with surgical gown **50**. Surgical gown **50** is sized so as to extend from a neck region of a user to a waist region of the user or below. Hood **12** of helmet **10** is sized so as to extend below the neck region of the user. In one desired configuration shown in FIG. **7**, a lower portion **120** of hood **12** (outlined with dash line M-M) is tucked within an upper portion **52** of surgical gown **50**. Desirably, when at least one air outlet **18** is present in hood **12**, the at least one air outlet **18** is positioned above upper edge **51** of surgical gown **50**. In such a configuration, upper portion **52** of surgical gown **50** effectively blocks air flow into surgical gown **50** and out through the at least one air outlet **18**.

It should be noted that helmets **10** and **100** as shown in FIGS. **1-7** are only two exemplary helmets of the present invention. Various modifications could be made to exemplary helmets **10** and **100** including, but not limited to, increasing the number of hood air inlet(s) **16** and/or the number of hood air outlets **18** and **19**; increasing or decreasing the size of one or more components (e.g., transparent face shield **11** and/or hood air inlet(s) **16** and/or hood air outlets **18** and **19**) relative to other components (e.g., hood **12**); and rearranging one or more components of exemplary helmets **10** and **100** (e.g., changing the position of fan **27** to a position closer to air inlet **22** and/or changing the position of hood air outlets **18** and **19** so as to be closer to transparent face shield **11** and/or further away from hood air inlet(s) **16**).

Typically, helmets of the present invention comprise from one to about five hood air inlet(s) **16**, from one to about five hood air outlets **18** and **19**, a single fan **27**, and a single air channel **25**; however, helmets of the present invention could comprise, for example, multiple fans and/or multiple air channels.

II. Methods of Making Helmets

The present invention is further directed to methods of making helmets. In one exemplary embodiment, the method of making a helmet comprises providing a frame of a helmet, the frame being operatively adapted to surround at least a portion of a person's head; attaching a transparent face shield to the frame so as to be positioned along a front side of the helmet; providing an air channel having at least one air inlet and at least one air outlet the air channel being attached to or integrally formed into the frame; providing a fan in fluid communication with the air channel, the fan being operatively adapted to move air through the air channel; incorporating a battery pack into the helmet, the battery pack being operatively adapted to supply electrical power to the fan; and providing a hood that surrounds the transparent face shield and extends over and downward from the frame. Desirably, the at least one air outlet is positioned so as to provide air to a space bound by an inner surface of the transparent face shield. In other desired embodiments, the battery pack is positioned above a lower edge of the transparent face shield, more desirably, above an upper edge of the transparent face shield.

In another exemplary embodiment, the method of making a helmet comprises providing a frame of a helmet, the frame being operatively adapted to surround at least a portion of a person's head; attaching a transparent face shield to the frame so as to be positioned along a front side of the helmet; providing an air channel having at least one air inlet and at least one air outlet, the air channel being attached to or integrally formed into the frame; providing a fan in fluid communication with the air channel, the fan being operatively adapted to move air through the air channel; and attaching a hood to the frame so as to surround the transparent face shield and extend over and downward from the frame, the hood comprising (i) at least one hood air inlet located within a periphery of the hood and aligned with the at least one air inlet of the air channel, and (ii) at least one hood air outlet located within a periphery of the hood, wherein the at least one hood air inlet and the at least one hood air outlet are operatively adapted to provide air flow through the helmet so as to decrease an amount of carbon dioxide buildup within the helmet. Desirably, the at least one air outlet is positioned so as to provide air to a space bound by an inner surface of the transparent face shield.

Any of the above-described individual components used to form the helmets of the present invention may be formed using conventional methods. For example, helmet components including, but not limited to, adjustable frame component **31**, first frame component **32**, second frame component **33**, third frame component **34**, knob extension member **37**, knobs **14** and **15**, air channel **25**, and transparent face shield **11**, may be formed from any thermoformable material including, but not limited to, polymeric materials, metallic materials, or a combination thereof. The thermoformable materials can be molded or shaped using any conventional molding technique. Typically, the above-mentioned helmet components are formed from polymeric materials such as polyolefins (e.g., polyethylene, polypropylene, and olefin copolymers), polyurethanes, acrylonitrile-butadiene-styrene (ABS) copolymers, polyesters, polyethylene terephthalate glycol (PETG), polyamides, etc.

Any films or film-like components including, but not limited to, adjustable frame component **31** and third frame component **34**, may be forming via any film-forming process including, but not limited to, a film extrusion process, a film-blowing process, etc.

Fiber-containing helmet components, such as hood **12** and first and second air filtration materials **61** and **62**, may be formed using conventional web-forming processes including, but not limited to, meltblowing processes, spunbonding processes, spunlacing processes, hydroentangling processes, carding processes, needlepunching processes, etc. Typically, the fiber-containing helmet components are formed from polymeric materials such as polyolefins (e.g., polyethylene, polypropylene, and olefin copolymers), nylon, acrylonitrile-butadiene-styrene (ABS) copolymers, etc.

Thermoformed parts, films and/or fabric layers may be joined to one another using any conventional bonding technique including, but not limited to, thermal bonding processes, adhesive bonding, mechanical bonding (e.g., hook and loop material), etc. In one exemplary embodiment of the present invention, the hood is formed from an Ahlstrom Corporation BVB Material (e.g., trilaminate polypropylene material) and is thermally bonded to an outer periphery of a transparent face shield formed from PETG using a conventional thermal-bonding apparatus (e.g., an ultrasound welder).

In one desired embodiment, the helmet of the present invention is formed from the following materials: a closed cell polyurethane foam molded helmet component (e.g., helmet component **78**); frame components (e.g., adjustable frame component **31** shown in FIG. **6**A) formed from polyethylene; a transparent face shield (e.g., transparent face shield **11**) formed from PETG; a frame component extending around the transparent face shield (e.g., frame component **32**) formed from polyvinyl chloride (PVC); head band material in the form of VELCRO® brand terry cloth; batteries—4 AAA Alkaline batteries; and air inlet and outlet material formed from CEREX® nylon spunbonded fabric.

III. Methods of Using Helmets in an Operating Room Setting

The present invention is further directed to methods of using the above-described helmets in an operating room setting. In one exemplary embodiment, the method comprises a method of providing a barrier between a surgeon (or other operating room personnel) and a patient in an operating room setting, wherein the method comprises the step of positioning the helmet over at least a portion of the surgeon's head (or any other operating room personnel's head) to separate the surgeon (or other operating room personnel) from a surgical procedure site. Typically, the helmet is used in combination with a surgical gown and other pieces of protective clothing (e.g., booties, gloves, etc.) to provide a barrier between the surgeon and a surgical procedure site.

In another exemplary embodiment, the present invention is directed to a method of reducing an amount of carbon dioxide within a surgical outfit during use. In this exemplary embodiment, the method comprises (A) providing a surgical outfit comprising (1) a helmet comprising (i) a frame operatively adapted to surround at least a portion of a person's head; (ii) a transparent face shield attached to the frame and positioned along a front side of the helmet; (iii) an air channel having at least one air inlet and at least one air outlet, the at least one air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield; and (iv) a fan in fluid communication with the air channel, the fan being operatively adapted to move air through the air channel; and (2) a hood or surgical gown surrounding the transparent face shield and extending over and downward from the frame, the hood or surgical gown comprising (i) at least one air inlet located within a periphery of the hood or surgical gown and aligned with the at least one air inlet of the air channel, and (ii) at least one air outlet located within a periphery of the hood or surgical gown; and (B) cutting on the fan to provide air flow along a path through the surgical outfit components in the following order: an air inlet in a surgical gown, at least one hood air inlet in a helmet, to at least one air inlet, through an air channel, out of at least one air outlet into a region of the helmet bound by a transparent face shield, out of the helmet through at least one hood air outlet, and out of the surgical gown through at least one air outlet in the surgical gown.

In one desired embodiment, the method of reducing an amount of carbon dioxide within a surgical outfit during use results in a carbon dioxide level of less than about 5000 ppm, more desirably, less than about 4000 ppm, even more desirably, less than about 3500 ppm, and even more desirably, less than about 3000 ppm (or less than about 2500 ppm, or less than about 2000 ppm, or less than about 1800 ppm).

The surgical outfit of the present invention also improves air flow through the surgical outfit. For example, air flow through a surgical outfit without at least one hood air outlet may be in the range of about 2.5 to about 3.4 cubic feet per minute (cfm), while air flow through a surgical outfit of the present invention with at least one hood air outlet can be in the range of about 3.9 to about 5.5 cfm, an increase in air flow of as much as 120%.

In some embodiments, the above-described methods may further comprise one or more of the following steps: sterilizing the helmet prior to use, removing the helmet from a packaging material, adjusting the helmet frame to fit snugly on the surgeon's head, checking the power supply to insure the fan is operational, combining the helmet with other pieces of protective clothing, tucking a portion of the hood of the helmet within a surgical gown, and turning on the power supply for the fan.

While the specification has been described in detail with respect to specific embodiments thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing, may readily conceive of alterations to, variations of, and equivalents to these embodiments. Accordingly, the scope of the present invention should be assessed as that of the appended claims and any equivalents thereto.

What is claimed is:

1. A helmet comprising:

a frame operatively adapted to surround at least a portion of a person's head;

a transparent face shield attached to the frame and positioned along a front side of said helmet;

an air channel having at least one air inlet and an air outlet consisting of a single air outlet, said single air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield;

a fan in fluid communication with the air channel, said fan being operatively adapted to move air through said air channel;

a battery pack attached to the frame and positioned above a lower edge of the transparent face shield and along opposite sides of the air channel, said battery pack being operatively adapted to supply electrical power to the fan; and

a hood surrounding the transparent face shield and extending over and downward from the frame.

2. The helmet of claim **1**, further comprising:

at least one hood air inlet located within a periphery of the hood and aligned with the at least one air inlet of the air channel.

3. The helmet of claim **1**, wherein the at least one hood air inlet is positioned along an outer surface of the helmet opposite the transparent face shield.

4. The helmet of claim **1**, further comprising:

at least one hood air inlet located within a periphery of the hood and aligned with the at least one air inlet of the air channel; and

at least one hood air outlet located within a periphery of the hood,

wherein the at least one hood air inlet is positioned along an outer surface of the helmet, and the at least one hood air outlet is positioned below the at least one hood air inlet.

5. The helmet of claim **1**, further comprising:

a power switch operatively adapted to (1) switch from an "off" position to an "on" position so as to supply power to the fan and turn off power to the fan, and optionally (2) provide variable speed settings for the fan.

6. The helmet of claim **5**, wherein the power switch is positioned along an upper periphery of the transparent face shield.

7. The helmet of claim **1**, wherein the battery pack is positioned along an outer surface of the helmet opposite the transparent face shield.

8. A surgical outfit comprising:

the helmet of claim **1**; and

a surgical gown sized so as to extend from a neck region of a user to a waist region or below,

wherein the hood of the helmet is sized so as to extend below the neck region of the user, and when a lower portion of the hood is tucked within an upper portion of the surgical gown, the at least one air outlet of the hood is positioned above the surgical gown.

9. A helmet comprising:

a frame operatively adapted to surround at least a portion of a person's head;

a transparent face shield attached to the frame and positioned along a front side of said helmet;

an air channel having at least one air inlet and an air outlet consisting of a single air outlet, said single air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield;

a fan in fluid communication with the air channel, said fan being operatively adapted to move air through said air channel;

a battery pack attached to the frame and positioned above a lower edge of the transparent face shield and along opposite sides of the air channel, said battery pack being operatively adapted to supply electrical power to the fan;

a hood surrounding the transparent face shield and extending over and downward from the frame;

at least one hood air inlet located within a periphery of the hood and aligned with the at least one air inlet of the air channel; and

at least one hood air outlet located within a periphery of the hood,

wherein the at least one hood air inlet and the at least one hood air outlet are operatively adapted to provide air flow through the helmet so as to decrease an amount of carbon dioxide buildup within the helmet.

10. The helmet of claim **9**, wherein the at least one hood air inlet is positioned along a rear side of the helmet opposite the transparent face shield, and the at least one hood air outlet is positioned below the at least one hood air inlet.

11. The helmet of claim **9**, wherein the at least one hood air inlet comprises a single hood air inlet, and the at least one hood air outlet comprises one or more air outlets positioned along a neck region of the hood.

12. The helmet of claim **9**, wherein each of the hood, the at least one hood air inlet, and the at least one hood air outlet comprises nonwoven fabric materials.

13. The helmet of claim **9**, wherein the helmet is sterilized.

14. The helmet of claim **9**, wherein the helmet is disposable.

15. A method of making a helmet suitable for use in an operating room setting, said method comprising:

providing a frame of a helmet, the frame being operatively adapted to surround at least a portion of a person's head;

attaching a transparent face shield to the frame so as to be positioned along a front side of the helmet;

providing an air channel having at least one air inlet and one air outlet, the one air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield, the air channel being attached to or integrally formed into the frame;

providing a fan in fluid communication with the air channel, the fan being operatively adapted to move air through the air channel;

incorporating a battery pack into the helmet so as to be positioned above a lower edge of the transparent face shield and along opposite sides of the air channel, the battery pack being operatively adapted to supply electrical power to the fan; and

providing a hood that surrounds the transparent face shield and extends over and downward from the frame.

16. The method of claim **15**, wherein the hood comprises:

at least one hood air inlet located within a periphery of the hood and aligned with the at least one air inlet of the air channel; and

one hood air outlet located within a periphery of the hood,

wherein the at least one hood air inlet and the one hood air outlet are operatively adapted to provide air flow through the helmet so as to decrease an amount of carbon dioxide buildup within the helmet.

17. A method of reducing an amount of carbon dioxide within a surgical outfit during use, said method comprising:

providing a surgical outfit comprising:

a helmet comprising:

a frame operatively adapted to surround at least a portion of a person's head;

a transparent face shield attached to the frame and positioned along a front side of said helmet;

an air channel having at least one air inlet and one air outlet, said one air outlet being positioned so as to provide air to a space bound by an inner surface of the transparent face shield;

a fan in fluid communication with the air channel, said fan being operatively adapted to move air through said air channel;

a battery pack attached to the frame and positioned above a lower edge of the transparent face shield and along opposite sides of the air channel, said battery pack being operatively adapted to supply electrical power to the fan; and

a hood surrounding the transparent face shield and extending over and downward from the frame; and

a surgical gown sized so as to extend from a neck region of a user to a waist region or below,

wherein the hood of the helmet is sized so as to extend below the neck region of the user, and when a lower portion of the hood is tucked within an upper portion of the surgical gown, the at least one air outlet of the hood is positioned above the surgical gown; and

cutting on the fan to provide an air flow path into the at least one hood air inlet, to the at least one air inlet, through the air channel, out of the at least one air outlet into a region of the helmet bound by the transparent face shield, and out of the helmet through the at least one hood air outlet.

18. The method of claim **17**, wherein the amount of carbon dioxide within the surgical outfit during use is below 2500 parts per million.

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